

## PATENT COOPERATION TREATY

## PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT  
(PCT Article 36 and Rule 70)

REC'D 15 DEC 2004

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Applicant's or agent's file reference PC471CF	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/EP 03/14703	International filing date (day/month/year) 22.12.2003	Priority date (day/month/year) 20.12.2002
International Patent Classification (IPC) or both national classification and IPC F16D65/14		
Applicant AKTIEBOLAGET SKF et al		

1. This International preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the opinion
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand  19.07.2004	Date of completion of this report  13.12.2004
Name and mailing address of the International preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer  Martinvalet, C-I  Telephone No. +49 89 2399-8185  

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. **PCT/EP 03/14703**

**I. Basis of the report**

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, Pages**

2-7 as originally filed  
1, 1a received on 19.11.2004 with letter of 17.11.2004

**Claims, Numbers**

1-14 received on 19.11.2004 with letter of 17.11.2004

**Drawings, Sheets**

1/5-5/5 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).  
☐ the language of publication of the international application (under Rule 48.3(b)).  
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.  
☐ filed together with the international application in computer readable form.  
☐ furnished subsequently to this Authority in written form.  
☐ furnished subsequently to this Authority in computer readable form.  
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.  
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:  
☐ the claims, Nos.:  
☐ the drawings, sheets:

**INTERNATIONAL PRELIMINARY  
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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes: Claims	1-14
	No: Claims	
Inventive step (IS)	Yes: Claims	1-14
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-14
	No: Claims	

2. Citations and explanations

**see separate sheet**

**Re Item V**

**Reasoned statement with regard to novelty and inventive step; citations and explanations supporting such statement**

Reference is made to the following document:

D1: D1: WO 01/70552 A (BOSCH GMBH ROBERT (2001-09-27))

**NOVELTY**

**Claim 1**

The present application meets the criteria of Article 33(1) PCT, because the subject-matter of claim 1 is new in the sense of Article 33(2) PCT.

The document **D1** is regarded as being the most relevant state of the art discloses:  
an electro-mechanical screw actuator assembly (10), comprising:  
a housing fixable to a motor vehicle,  
an electric motor (18) mounted within the housing and comprising a stator fixed to the housing and a rotor,  
a screw mechanism (48) including a translatable nut (62) and a central screw (50) rotatable along a given axis,  
a gear reduction means (34) disposed between the rotor and the screw mechanism for provoking a translation of the nut (62),  
wherein the housing is secured to or integral with a supporting element of essentially tubular cylindrical shape extending within the housing coaxial to said axis, wherein the supporting element externally rotatably supports the rotor of the electric motor, and internally rotatably supports the nut of the screw mechanism. (Fig.3).

**INVENTIVE STEP**

The subject-matter of claim 1 differs from this known electro-mechanical screw actuator assembly in that the supporting member supports externally at least one fixed gear of the gear reduction means.

The problem to be solved by the present invention may be regarded as reducing the play between the transmission members of the assembly.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons: the prior art documents do not suggest the differencing features.

**Dependent claims 2-14**

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/EP 03/14703

Claims 2-14 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

**FURTHER REMARK:**

The features introduced in claim 3 concerning the axial cavity (24) are not mentioned in claim 1 but in claim 2, so claim 3 should be dependent from claim 2.

An electro-mechanical screw actuator assembly

The present invention refers to an electro-mechanical screw actuator assembly of the type mentioned in the preamble of claim 1.

Actuator assemblies of the above type are known, for example, from US-6 315 092. These actuators are applied in various fields, for example in the automotive field for actuating brakes, friction clutches, gearboxes, etc. An electric motor, mounted within a housing fixable to the vehicle, drives for rotation a nut member of a screw mechanism through a gear reduction system. The screw mechanism comprises a screw connected to a piston actuating head which is imparted a reversible linear motion with a high actuating force.

A problem encountered with conventional electro-mechanical actuator assemblies is due to the play between the various transmission members of the assembly, that are generally cascade connected. The tolerance of the couplings between the transmission members add up, allowing misalignment between the rotation or translation axes of these members, that are so subjected to early and non-uniform wear. Particularly, with use, the gears of the planetary reduction system have a tendency to wear very quickly if they are not kept correctly aligned parallel to the central longitudinal axes of the actuator, that coincides with the axis of translation of the piston member. An excessive increase of the play and the consequent misalignment of the axes of the transmission members leads to a loss of efficiency of the actuator assembly and shortens its life.

WO 01/70552 A discloses an electro-mechanical screw actuator assembly, comprising:

AMENDED SHEET

a housing fixable to a motor vehicle,  
an electric motor mounted within the housing and  
comprising a stator fixed to the housing and a rotor,

a screw mechanism, including a translatable nut and a  
central screw rotatable translatable along a given axis,

a gear reduction means disposed between the rotor and  
the screw mechanism for provoking a translation of the nut.  
The housing is secured to or integral with a supporting  
element of essentially tubular cylindrical shape extending  
within the housing coaxial to said axis, wherein the  
supporting element externally rotatably supports the rotor  
of the electric motor, and internally rotatably supports the  
nut of the screw mechanism.

The object of the present invention is therefore to provide  
an electro-mechanical screw actuator assembly, adaptable to

CLAIMS

1. An electro-mechanical screw actuator assembly, of the type comprising:

a housing (11) fixable to a motor vehicle,  
an electric motor (30) mounted within the housing (11) and comprising a stator (31) fixed to the housing (11) and a rotor (34),

a screw mechanism (60), including a rotatable nut (61) and a central screw (62) translatable along a given axis (x),

gear reduction means (50) disposed between the rotor (34) and the screw mechanism (60) for provoking a translation of the screw (62),

wherein the housing (11) is secured to or integral with a supporting element (21) of essentially tubular cylindrical shape extending within the housing (11) coaxial to said axis (x), and wherein the supporting element (21)

externally, rotatably supports the rotor (34) of the electric motor (30), and

internally, rotatably supports the nut (61) of the screw mechanism (60);

characterized in that the supporting member (21) supports externally at least one fixed gear (55) of the gear reduction means (50).

2. An actuator assembly according to claim 1, characterized in that the supporting member (21) forms an axial cavity (24) for accommodating and axially guiding a piston member (70) fixed to or integral with the screw (61) of the screw mechanism (60).

3. An actuator assembly according to claim 1, characterized in that at the interface between the axial



cavity (24) of the supporting member (21) and the piston member (70) there is provided an axial splined coupling or a form coupling (26) for preventing rotation of the screw (62) and/or the piston member (70) with respect to the housing (11).

4. An actuator assembly according to claim 1, characterized in that the supporting member (21) is formed by a rigid body (20) having also a supporting means (23) for mounting the stator (31) of the electric motor (30).

5. An actuator assembly according to claim 1, characterized in that the gear reduction means (50) include a planetary gear reduction system.

6. An actuator assembly according to claim 5, characterized in that the rotor (34) forms a radial flange (36) that serves as a carrier for a plurality of satellite gears (52).

7. An actuator assembly according to claim 6, characterized in that each of the satellite gears (52) has two toothed portions (53, 54), of which:

- a first toothed portion (53) meshes with a fixed gear (55) fast with the tubular supporting member (21) and
- a second toothed portion (54) meshes with a gear (56) fast for rotation with the nut (61).

8. An actuator assembly according to claim 1, characterized in that the screw mechanism (60) is rotatably supported at an end thereof by an angular contact ball bearing (44).

9. An actuator assembly according to claim 8,

characterized in that the radially outer raceway of the angular contact ball bearing (44) is formed at least partially by a sleeve member (45) axially locked onto the housing (15).

10. An actuator assembly according to claim 9, characterized in that the sleeve member (45) is axially locked onto the housing (11) by cold forming an end portion (47') of the sleeve member (45) deformed in a radially outer direction against a radial wall (14) of the housing (11).

11. An actuator assembly according to claim 9, characterized in that the radially outer raceway of the angular contact bearing (44) is formed entirely by a sleeve member (45), whilst the radially inner raceway is formed partly by the nut (61) and partly by a separate annular member (48') axially locked (49') onto the nut.

12. An actuator assembly according to claim 11, characterized in that the separate annular member (48') is axially locked onto the nut (61) by cold forming an end portion (61') of the nut that is deformed in a radially outer direction against a radial wall of the separate ring (48').

13. An actuator assembly according to claim 1, characterized in that the screw mechanism (60) includes a ballscrew.

14. An actuator assembly according to anyone of the preceding claims, characterized in that it is coupled with a brake caliper (A) for operating a braking force on a motor vehicle.